

journeyman electrician's workbook

exam preparation-upgrading

BASED ON THE 1990 NEC®



JOB APPROVED

an



publication

James G. Stallcup

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Introduction

The JOURNEYMAN ELECTRICIAN'S WORKBOOK, Exam Preparation—Upgrading, Based on the 1990 NEC® is designed for use by electricians preparing to take the Journeyman Electrician's License Examination and for upgrading. The National Electrical Code® 1990 must be used with this workbook. Copies of the NEC® 1990 may be ordered directly from the publisher:

National Fire Protection Association, Inc.
Batterymarch Park
Quincy, MA 02269

The material in this workbook is presented in a sequential order, building upon prior material, and concludes with two sample examinations. Answers to these two examinations are given in the Instructor's Guide. Examples show how to solve electrical problems and are followed by Guided Exercises, which should be completed in the spaces provided. Answers to Guided Exercises are given in the back of this workbook. Answers to Problems are given in the Instructor's Guide. Chapters conclude with questions and/or problems related to material in that specific chapter. Answers to Questions/Problems at the end of chapters are given in the Instructor's Guide.

Chapter 7 has sixteen 25-question assignments. General Questions, Parts 1 and 2 contain general electrical questions. Code-related Questions, Parts 1 through 14 contain NEC® related questions. These questions are from all chapters in the 1990 NEC® and are designed to give the user practice in applying the NEC® to substantiate answers. Answers to Chapter 7 questions are given in the Instructor's Guide.

The Publisher

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THE JOURNEYMAN'S EXAMINATION_____chapter 1

The purpose of licensing examinations is to allow electricians equal opportunity to demonstrate a working knowledge of electricity commensurate with, or exceeding, minimum standards set by the National Electrical Code® and the authority having jurisdiction in the area. Some states and local areas require licensing examinations as a prerequisite for working at the journeyman level. Other states and local areas do not require licensing examinations as a prerequisite for working at the journeyman level.

Examinations are given for state and local licensing. These examinations may be prepared, administered, and graded by state or local authorities, or by organizations such as Block and Associates or Educational Testing Service. Additionally, state or local authorities may administer tests prepared by testing organizations. To determine the type of test given in your area, check with the authority having jurisdiction.

The length of electrical examinations varies from area to area and state to state. Usually, these examinations are three, four, or six hours in length. Some areas give all open book examinations, while in other areas, a closed book and open book examination may be administered. Examinations may be divided into parts. For example, a morning session could include general questions and an afternoon session could include calculations and longer problems.

Rules concerning items such as reference material, calculators, and notes that may be taken into the examination room vary from local area to local area and from state to state. Specific test formats and instructions for taking the Journeyman's Licensing Examination are the responsibility of the authority having jurisdiction. Always check with the authority having jurisdiction in your area if you have any questions concerning licensing examinations.

Specific test questions and problems for the journeyman electrician's examination are based upon general electrical knowledge, trade experience, and the National Electrical Code®. Check with the authority having jurisdiction to determine the particular edition of the National Electrical Code® adopted for the state or area in which the test is being given.

The sample pages immediately following are provided courtesy of Block and Associates. The sample pages thereafter are provided courtesy of Educational Testing Service. These two organizations prepare, administer, and grade competency examinations for the construction industry.

**SAMPLE RULES
AND INFORMATION**
Block and Associates

**BLOCK AND ASSOCIATES
EXAMINATION RULES AND INFORMATION**

(Enforced at Proctored Examinations—Recommended at All Exams)

A. CALCULATORS:

1. The use of calculators will be permitted only if the machine is completely silent, cordless, produces no tape, and is small enough that it will not infringe on other applicants space.

B. REFERENCES:

1. Applicants must provide their own references. No material of any sort may be shared by applicants.
2. Only those books and references listed on the suggested reference list will be permitted in the examination room. All briefcases, books, etc., may be inspected by the proctors. Questions will come from these references.
3. No notes of any sort will be allowed.

C. SCRATCH PAPER:

1. No paper of any sort is to be brought to the examination. Use the back of the pages in the examination for scratch paper.

D. NOTE TAKING:

1. No part of the examination may be copied or reproduced in any manner, or removed from the examination room. If notes are made in references, the proctor will pick up the references and turn them in to the examining board.

E. TALKING:

1. No talking will be permitted in the examination room during the examination.

F. SMOKING:

1. No smoking will be permitted in the examination room.

G. APPLICANT NUMBER:

1. Do not put your name on the exam, use the assigned applicant number only.

VIOLATION of any of the above rules will disqualify the applicant and no grade will be issued. Legal and disciplinary action will be taken by Block and Associates and the Examining Board.

H. QUESTIONS:

1. No technical questions of any sort will be answered by the proctors. If you do not understand a question on the examination, do your best to answer it.
2. If you feel a question has an error in it, notify the proctor, who will see that the grader is informed.
3. Answer all questions. There is no penalty for guessing.

I. MATERIALS:

1. Bring all references, a #2 pencil, an eraser, a calculator, and identification documents (one with your picture).

**BLOCK AND ASSOCIATES
MASTER and JOURNEYMAN ELECTRICIAN EXAMINATIONS
GENERAL INFORMATION**

Each examination consists of three parts. Parts I and II are made up of multiple choice and true-false questions. These two parts count fifty percent of the total examination grade.

Part I (Closed Book - One Hour) includes definitions, general information of the type the electrician would used in his daily work and basic theory.

Part II (Open Book - Two Hours) includes specific code questions taken from the National Electrical Code. It also includes some more theory questions.

If there is a difference between the National Electrical Code and a local code, the applicant is expected to use the N.E.C. on parts I, II and III.

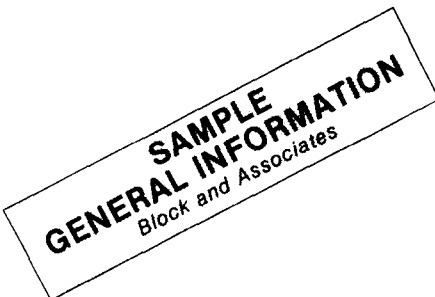
The Journeyman Examination has fewer questions in Part II and excludes more than a basic understanding of three phase systems. Problems in Part III are restricted to residential and small commercial work.

Part III consists of thirty short problems. Usually data is furnished and several problems are asked for each set of data.

Following are problems which may be included in Part III.

1. Residential load
2. Load balancing, 1 ϕ
3. Single phase transformers, primary and secondary currents, voltages and volt
amps
4. Single phase voltage drop
5. Ambient temperature correction factors
6. Single phase motor protection
7. Conduit fill
8. Commercial and industrial loads
9. Load balancing, 3 ϕ
10. Three phase transformers, primary and secondary currents, voltages and volt
amps
11. Three phase voltage drop
12. Three phase motor protection
13. Other examples in the N.E.C.

1-7 Journeyman Electrician
1-13 Master Electrician



BLOCK AND ASSOCIATES
JOURNEYMAN, RESIDENTIAL and MASTER ELECTRICIAN EXAMINATIONS
SAMPLE QUESTIONS, PARTS I and II

Power is equal to --.

I - V^2/W

II - $I^2 R$

III - IR

a) I only

c) III only

b) II only

d) I, II and III

Underfloor raceways may be occupied up to -- percent of the area.

a) 20

c) 40

b) 30

d) 60

Circuit breakers, when used on services of over 600 volts, when not enclosed in a vault, shall be of which of the following?

a) molded-case type

c) instantaneous

b) non-inductive type

d) thermal-inductive

Flexible cord approved for use with specific appliances shall be considered as protected by a 20 amp branch circuit, circuit breaker if it is --.

a) No. 18 or larger

c) No. 16 or larger

c) No. 20 or larger

d) not less than 6' in length

All wires No. -- or larger must be stranded when used in conduit.

a) 12

c) 8

b) 10

d) 6

Fittings include--.

a) locknuts

c) conductors

b) wire nuts

d) busbars

A three wire -- volt branch circuit is the equivalent of two 115 volt receptacle branch circuits.

a) 115

c) 240

b) 230

d) none of these

The service conductors supplying each building shall not pass through the inside of another building unless --.

I - these buildings are under single occupancy

II - these buildings are under single management

III - these buildings are on one meter

a) I only

c) III only

b) II only

d) I, II and III

SAMPLE QUESTIONS
PARTS I AND II
Block and Associates

**BLOCK AND ASSOCIATES
JOURNEYMAN ELECTRICIAN EXAMINATION
PART III SAMPLE QUESTIONS**

A dwelling has a floor area of 1500 square feet exclusive of unoccupied cellar, unfinished attic and open porches. It has a 12-KW range.

The general lighting load is -- watts.

- a) 1500
- b) 3000
- c) 4500
- d) 6000

The number of 20 amp branch circuits is --.

- a) 2
- b) 3
- c) 4
- d) 5

The demand load for the range is -- watts.

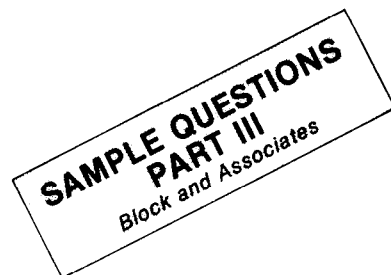
- a) 12,000
- b) 10,000
- c) 8,000
- d) 6,000

The net computed load without the range is --Kwatts.

- a) 3-4
- b) 4-5
- c) 5-6
- d) 6-7

The net computed load with the range in amps is -- amps.

- a) 30-40
- b) 45-50
- c) 55-60
- d) 80-100



NATIONAL ASSESSMENT INSTITUTE JOURNEYMAN EXAMINATION

What is the Content of the Journeyman Test?

The Journeyman exams are based on the following content areas. Under each subject heading is shown the approximate percentage of questions in that subject area for each exam.

1. **Grounding and Bonding (approximately 12%)**
Determination of system and circuit grounding requirements, methods and location of grounding connections. Choosing proper size grounding conductors, bonding of enclosure, equipment, and interior metal piping systems.
2. **Branch Circuits, Wire Connections and Devices (approximately 11%)**
Knowledge of circuit classifications, ratings, design and use requirements. Knowledge and calculation of branch circuit loads. Application of code rules covering electrical outlets, devices, including wire connectors and methods.
3. **Conductors (approximately 10%)**
Determination of ampacity, type of insulation, usage requirements, methods of installation, protection, support, and termination. Includes calculation, voltage drop and derating.
4. **General Knowledge of the Electrical Trade (approximately 11%)**
Terminology and practical calculations such as power factor, voltage, and current ratings of equipment.
5. **Motors and Control of Motors and Equipment (approximately 11%)**
Knowledge of code rules governing installations of motors and controls. Includes calculations for motor feeder and branch circuits, short circuits, ground fault, overload protection, and disconnecting means. Knowledge of all control circuits and motor type application and usage.
6. **Services and Feeders (approximately 9%)**
Knowledge of code rules covering services. Calculation of electrical loads and determination of proper size and type of service and feeder conductors and ratings.
7. **General Use Equipment (approximately 10%)**
Knowledge of code rules covering appliances, heating, and air conditioning equipment, generators, transformers, etc.
8. **Overcurrent Protection (approximately 5%)**
Knowledge of application of fuses and circuit breakers and all types of protective devices for conductors and equipment. Includes rules on taps and splices.
9. **Raceways (approximately 5%)**
Knowledge of all types of raceways and their uses. Determining proper size, conductor fill, support, and methods of installation.
10. **Special Occupancies and Equipment (approximately 4%)**
Knowledge of code rules as they apply to hazardous locations, health care facilities, places of assembly, etc. Includes code rules on signs, welders, industrial machinery, swimming pools, etc.
11. **Boxes, Cabinets, Panelboards, and Non-raceway Enclosures (approximately 7%)**
Application of proper type, use, and support of boxes and cabinets, etc. Calculation of proper size and rating.
12. **Low Voltage Circuits Including Alarms and Communications (approximately 2%)**
Knowledge of circuits and equipment operating at less than 50 volts. All signal, alarm, and sound systems.
13. **Lighting and Lamps (approximately 2%)**
Knowledge of all types and applications of light fixtures, ratings, requirements for occupancies, special provision, clearances, etc. Includes load calculations for lighting.
14. **Reading and Interpreting Plans, Specifications, and Drawings (approximately 2%)**
Knowledge and use of symbols, schematics, and drawings.

SAMPLE INFORMATION
National Assessment Institute

What are the Procedures in Applying for and Taking the Test?

When you apply to take the Journeyman Electrician examination, you will usually receive a *Candidate Bulletin of Information*. This brochure explains the examination application and registration details. It includes the administrative procedures which will be followed at the examination. The Bulletin of Information also includes a description of the examination showing the content areas and how many questions there are in each. The following pages contain a sample of the Bulletin of Examination.

EXAMINATION APPLICATION, ELIGIBILITY AND REGISTRATION

Before registering for an examination, you must apply to the licensing officials in your jurisdiction. Eligibility to take a licensing examination is determined by the licensing authorities. Applications must be legible and completed in full. If your application is not filled in accurately and completely, it will be returned to you, thus delaying your registration for the exam.

If you have fulfilled the application requirements, it is to your advantage to submit your application well in advance of the deadline date in case corrections or additional information is needed.

Once you are approved for the examination, you then must register with the independent testing agency to take the exam. For detailed information about eligibility and application requirements, contact the licensing authority in the jurisdiction where you wish to be licensed.

DATES, LOCATIONS AND FEES

Dates and locations are given in the Bulletin of Information and are established in advance. You must pre-register for the exam. You will not be allowed to just walk in and expect to pay the fee at the test site and then take the test.

In most cases, the exam fee is separate from the application and licensing fees and must be paid to the testing agency. Typical of many licensing jurisdictions are three separate fees: (1) an

application fee, (2) an examination fee, and (3) a licensing fee. The licensing fee is usually paid after you have passed the exam.

CANDIDATES WITH SPECIAL NEEDS

If a physical handicap prevents you from taking the exam under normal conditions, you may request special arrangements. Please submit documentation of your handicap to the Licensing Authorities with your application to help determine what special arrangements are necessary.

ADMISSION TO THE EXAM

Once you have been approved and registered in advance for the exam by mailing the exam fee and registration form, you will be sent an admission letter or ticket. This admission letter shows you the exact location of the exam and the time for reporting to the exam center. Most exams are administered on Saturday, usually at 8:00 a.m. and 9:00 a.m.

Examinations begin promptly at the time shown on your admission letter. You should report to the exam center approximately one-half hour before starting time to go through the check-in process. Candidates who arrive after check-in has been completed could possibly not be admitted (depending on how late they are) and examination fees are forfeited.

At the conclusion of candidate check-in, the exam supervisor will distribute materials and provide instructions for completing the answer sheet. The exam supervisor will read aloud a set of instructions for taking the examination.

- **Listen to the directions carefully.**
- **Read all directions carefully.**
- **Ask any questions** about the administrative procedures before the start signal is given.

During the examination you will be provided with scratch paper. Do not bring any notes or loose papers.

You will not be permitted to work beyond the time allotted for the examination.

All scratch work must be done on the scratch paper provided to you. Do not mark on the examination booklets or make stray marks on the answer sheet.

Your responses must be marked on the answer sheet if you are to receive credit for them. You will not be given credit for anything written anywhere else. The answer sheets are electronically scanned, so be careful to mark them properly.

Candidates may leave the examination room only after obtaining permission from the examination supervisor. You may not eat, drink, or smoke in the examination room at any time during the exam.

The entire question pool, each form of the examination, and the answer sheet are copyrighted and the property of National Assessment Institute. Any distribution of examination content or materials through any form of reproduction or oral or written communication is strictly prohibited and punishable by law.

QUESTION COMMENT FORMS

At the time of the examination you will be furnished a *Question Comment Form*. Examination proctors are not qualified or allowed to answer any questions concerning examination content. If you have any reason to question anything in the exam, you should write your comments on this Question Comment Form.

WHAT TO BRING TO THE EXAMINATION

At check-in you must present your admission letter and one official, photo-bearing identification, such as a driver's license, passport, or state-issued ID card.

You should take at least two #2 pencils to mark your answer sheet.

Usually, the only reference materials allowed to be used at the electrical examination is the *National Electrical Code*. Most licensing jurisdictions do not allow the hardcover *National Elec-*

trical Code Handbook or any other reference books. Some examinations may contain questions based on state law, and copies of the particular state law may be allowed in the exam.

You may also take a silent, non-printing calculator. A battery-powered calculator is sometimes better than a solar-powered one because the light may not always be sufficient to operate the calculator in a room like a big auditorium.

SCORES

Your score will be based on the number of questions you answer correctly. You will not be given credit for any question which has been answered incorrectly, left blank, or marked with more than one answer. Be sure to mark an answer for each question. There is no penalty for guessing.

A minimum score of 70% is required to pass your examination. A score report will be mailed to you approximately two weeks after the test date. All score reports are mailed simultaneously. Score reports will provide you with the information regarding the next step in the licensure process. To insure confidentiality, **scores will not be given over the telephone.**

REVIEWS

The review is a study session conducted similar to an exam. The purpose of the review is to allow you to see the questions you failed on the last exam. The review is not for the purpose of teaching the examination subject material. You are not allowed to take an advisor or anyone with you to the review.

If you do not pass the exam, you may register for the review by sending the appropriate fee. The fee for the review is usually the same as for the examination. In some jurisdictions you may only review the exam after two unsuccessful attempts to pass. You may only review the last exam you sat for which must be the last one administered. For example, you are not allowed to review an exam you took six months or a year previous.

SAMPLE QUESTIONS

1. Conductors within electrical nonmetallic tubing may not exceed _____ volts.

- | | |
|---------|---------|
| (A) 300 | (C) 500 |
| (B) 450 | (D) 600 |

2. Given: Six 230 volt, No. 8 AWG copper conductors with type TW insulation are to be installed in a single raceway.

The maximum allowable load current of each conductor is _____ amperes.

- | | |
|--------|--------|
| (A) 28 | (C) 40 |
| (B) 32 | (D) 50 |

3. Given: A 25 horsepower, synchronous, code letter A motor is to be installed with 460 volt, 3-phase alternating current.

The largest nontime delay fuse to provide short-circuit and ground-fault protection for the motor is _____ amperes.

- | | |
|--------|--------|
| (A) 30 | (C) 50 |
| (B) 40 | (D) 60 |

4. When service entrance phase conductors are larger than 1,750 kcmil aluminum, the bonding jumper should have an area of not less than _____ percent of the area of the largest phase conductor.

- | | |
|----------|----------|
| (A) 8.5 | (C) 12.5 |
| (B) 10.0 | (D) 20.0 |

5. Given: A five-family apartment building is supplied by a 120/240 volt, 3-wire service. Each apartment has a calculated load of 40 kVA.

According to the optional multifamily-dwelling calculation, the load of a 3-wire service for this building should not be less than _____ kVA. Select the closest answer.

- | | |
|--------|--------|
| (A) 80 | (C) 88 |
| (B) 88 | (D) 90 |

DEFINITIONS

chapter 2

DEFINITIONS

Definitions are found in Article 100 of the National Electrical Code. These terms are given to assure proper use of the Code. Part A lists definitions used throughout the Code. Part B definitions are terms used specifically in conjunction with installations and equipment that operate at over 600 volts, nominal.

The following terms are frequently used throughout the Code. NEC references are given for additional information pertaining to applicable sections of the Code. For a complete listing of all defined terms in the Code, see Article 100.

Accessible. Wiring methods can be removed or exposed without damage to the building structure or finish. Equipment is positioned and located to allow close approach. The term "readily accessible" refers to equipment or other items that can be reached quickly without climbing over or removing obstacles, or using means of elevations such as ladders or chairs.

Ampacity. Current in amperes which a conductor can carry continuously under conditions of use without exceeding its temperature rating.

- (1) More than three current-carrying conductors in a raceway—see Note 8(a) to Tables 310-16 through 310-19.
- (2) Ambient temperature surrounding conduit—see Ampacity Correction Factors to Tables 310-16 through 310-19.
- (3) Continuous duty loads—see 210-22(c), 220-3(a), 220-10(b), and 384-16(c).

Appliance. Standard sizes and types of utilization equipment that perform one or more functions, for example, water heaters, clothes washers and dryers, heating units.

Attachment Plug. A pronged device inserted into a receptacle to connect loads.

Automatic. Capable of self-operation when actuated by an outside influence. For example, current changes will automatically operate a device without continued supervision.

Bonding. Joining metal parts together to form a continuous path assuring electrical continuity. A bonding jumper is a conductor used to connect metal parts.

- (1) Bonding on the line side—250-79(d).
- (2) Bonding on the load side—250-79(e).
- (3) Grounding path—250-53(b).

Branch Circuit. The conductors connecting the last load(s) of the circuit to the overcurrent protection device. Branch circuits include individual, multiwire, and general purpose circuits.

Building. Any stand-alone structure. A structure separated from an adjoining structure by a fire wall. Note: Any openings in a fire wall of adjacent structures must have approved fire doors.

Circuit Breaker. An overcurrent protection device designed to trip open when current exceeds its rating. Circuit breakers may be adjustable, instantaneous trip, inverse time, non-adjustable, or setting types.

Concealed. Not accessible.

Conductor. A material that carries electricity. Conductors may be bare, covered, or insulated.

- (1) Types of insulation—Table 310-13.

(2) Ratings of conductors—Tables 310-16 through 310-19.

(3) Cross-sectional area—Table 5, Ch. 9.

Continuous Load. Any load where the maximum current may continue for three hours or more.

Cooking Equipment. Any cooking appliance with one or more heating element(s). For example, ranges, cooktops, and wall-mounted ovens are cooking equipment.

(1) Ratings—Table 220-19.

(2) Neutral—220-22; 210-19(c).

(3) Groundings—250-60; 250-61.

Cutout Box. A recessed, surface-mounted enclosure with swinging doors to protect interior components.

Dead Front. A cover or plate that prevents ready access to live parts of electrical equipment.

Demand Factor. A percentage of the maximum demand of a system. Demand factors are used to reduce the load of a system.

(1) Ranges—Table 220-19.

(2) Dryers—220-18.

(3) Fixed appliances—220-17.

(4) Cooking equipment—Table 220-20.

(5) School loads—Table 220-34.

(6) Existing loads—220-35; Table 220-32.

(7) Optional loads—Table 220-30; Table 220-32.

Device. Electrical system units that carry, but do not use, electricity. Common devices are circuit breakers, start-and-stop stations, pressure switches, and limit switches.

Disconnecting Means. A device that is used to disconnect loads from their electrical source. Common disconnecting means are safety switches, circuit breakers, and snap switches.

(1) Maximum height—380-8(a).

(2) Number—230-71.

(3) Location—230-70(a).

(4) Grouping—230-72.

(5) Access—230-72(c).

(6) In-sight—430-102; 430-107.

Duty. The operation of a load in an electrical system.

(1) Non-continuous—220-10(b).

(2) Continuous—220-10(b).

(3) Intermediate—Table 430-22(a), Ex.

(4) Periodic—Table 430-22(a), Ex.

(5) Short-time—Table 430-22(a), Ex.

(6) Varying—Table 430-22(a), Ex.

(7) Duty cycle—630-31(b).

Dwelling. A unit of one or more rooms that is used for housekeeping and has space for eating, sleeping, living, cooking, and sanitation.

One-family: one dwelling unit.

Two-family: two dwelling units.

Multifamily: three or more dwelling units.

Enclosure. An apparatus case or housing, or installation walls or fences, used to prevent accidental contact by personnel. Enclosures are also used to protect equipment from physical damage.

(1) Sizings—Table 373-6(a)(b).

(2) Wet locations—300-6(c).

(3) Secured—300-11.

(4) Accessibility—380-8(b).

(5) Types—300-6(a).

Equipment. Any material, fitting, device, appliance, or fixture that is a part of, or that is used in connection with, an electrical installation.

Feeder. Any circuit conductor between service equipment and the final overcurrent protection device of a system.

Fitting. An accessory that performs a mechanical function. Locknuts, bushings, and couplings are fittings.

Ground. A connection to the earth. Grounds may be intentional or accidental.

Grounded. Connected to the earth or a body serving in place of earth.

(1) Waterpipe—250-81(a).

(2) Building steel—250-81(b).

(3) Concrete-encased electrode—250-81(c).

(4) Ground ring—250-81(d).

(5) Rod, pipe, or plate—250-83; 250-84.

Grounded Conductor. Any system or circuit conductor that is intentionally grounded.

(1) Sizing—250-23(a)(b).

(2) Two or more buildings—250-24.

(3) Line or load side—250-61(a)(b).

(4) Subpanels—384-20.

Grounding Conductor. A conductor that connects a wiring system to a grounding electrode.

Grounding Electrode Conductor. A conductor that connects noncurrent-carrying metal parts of equipment or enclosures to the grounded terminal bar of the service equipment.

(1) Fixed equipment—250-42; 250-43.

(2) Cord-and-plug connected equipment—250-59; 250-45.